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SITE-SPECIFIC WORK PLAN FOR THE PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION AT SHAW AFB, SOUTH CAROLINA

August 2001

Prepared for:

Air Force Center for Environmental Excellence
Technology Transfer Division
and
Air Force Environmental Directorate

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LIST OF ACRONYMS AND ABBREVIATIONS

AFILEV	Air Force Environmental Directorate
AFB	Air Force Base
AFCEE/ERT	Air Force Center for Environmental Excellence, Technology Transfer Division
ANOVA	analysis of variance
AOC	Area of Concern
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene and xylenes
COPCs	chemicals of potential concern
DoD	Department of Defense
DSITMS	Direct Sampling Ion Trap Mass Spectrometry
FT-01	Former Fire Training Area No. 1
ft/day	feet per day
ft^2/day	square feet per day
ft/yr	feet per year
GIS	Geographical information system
HASP	Health and Safety Plan
LTM	long-term monitoring
OU	operable unit
µg/L	micrograms per liter
Parsons	Parsons Engineering Science, Inc.
PCE	tetrachloroethene
PDBS	passive diffusion bag sampler
POL	petroleum, oil, and lubricants
QAPP	Quality Assurance Program Plan
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SOPs	Standard Operating Procedures
SVOCs	semivolatile organic compounds
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TO	task order
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 Project Description

On 27 February 2001, Parsons Engineering Science, Inc. (Parsons) was awarded a task order (TO) under Air Force Center for Environmental Excellence (AFCEE) contract F41624-00-D-8024 (TO24, Project Air Force Environmental Directorate [AFILEV]) to demonstrate the use of passive diffusion bag samplers (PDBSs) in existing groundwater monitoring programs at selected AFILEV installations. The site of the PDBS demonstration outlined in this work plan is Shaw Air Force Base (AFB) located in Sumter, South Carolina. The Technology Transfer Division of AFCEE (AFCEE/ERT) has initiated the PDBS demonstration to introduce this technology to multiple Department of Defense (DoD) installations and to improve the cost effectiveness of groundwater monitoring programs for volatile organic compounds (VOCs).

Diffusion sampling is a relatively new technology designed to utilize passive sampling techniques that eliminate the need for well purging. Specifically, a diffusive-membrane capsule is filled with deionized/distilled water, sealed, suspended in a well-installation device, and lowered to a specified depth below the water level in a monitoring well. Over time (no less than 72 hours), the VOCs in the groundwater diffuse across the membrane, and the water inside the sampler reaches equilibrium with groundwater in the surrounding formation. The sampler is subsequently removed from the well, and the water in the diffusion sampler is transferred to a sample container and submitted for laboratory analysis of VOCs. Benefits of diffusion sampling include reduced sampling costs and reduced generation of investigation-derived waste.

1.2 Objective

The PDBS demonstration at Shaw AFB has two primary objectives:

- Develop vertical profiles of VOC concentrations across the screened intervals of the sampled monitoring wells, and

- Assess the effectiveness of PDBS by statistically comparing groundwater analytical results for VOCs obtained using the current (conventional) sampling method (i.e., 3-casing-volume purge/sample) during the upcoming October 2001 long-term monitoring (LTM) event with results obtained using the PDBS method.

Vertical contaminant profiles will be developed by placing PDBSs at discrete depths in each monitoring well included in the demonstration, and analyzing the resulting samples for VOCs. The statistical comparison of the conventional and diffusion sampling results will allow assessment of the appropriateness of implementing diffusion sampling for VOCs at each sampled well.

1.3 Scope

The Shaw AFB PDBS sampling demonstration will require two mobilizations to the site: one to place the diffusion samplers in the selected monitoring wells, and a second to retrieve the samplers from the wells. The PDBSs will be installed during the fourth week of September 2001 (i.e., Sept. 24-25) to provide adequate equilibration time before the current environmental contractor for Shaw AFB, the United States Army Corps of Engineers (USACE), begins the scheduled LTM sampling event on October 8, 2001. The PDBSs will be retrieved on October 8-9, immediately prior to the conventional sampling of the same wells to ensure temporal comparability of the analytical results obtained using the two methods. The PDBSs will be in place for a minimum of 14 days, which fulfills the 14-day minimum equilibration time period specified in the AFILEV PDBS Project Work Plan (Parsons, 2001).

1.4 Document Organization

This work plan is organized into seven sections, including this introduction, and one appendix. The Shaw AFB site description is presented in Section 2. Section 3 presents the scope of the PDBS investigation at Shaw AFB. Project organization, schedule, and an overview of the PDBS site-specific results report are summarized in Sections 4, 5, and 6, respectively. References used in the preparation of this work plan are presented in Section 7. A site-specific addendum to the Project Health and Safety Plan (HASP) (Parsons, 2001) is provided in Appendix A.

2.0 SITE DESCRIPTION

2.1 Location and Description of Shaw Air Force Base, South Carolina

Shaw AFB is located in Sumter County, South Carolina, approximately 7 miles west of the City of Sumter and 36 miles east of Columbia. The base includes approximately 13,313 acres and is surrounded by a semirural area consisting primarily of wooded and agricultural land. Some residential and commercial development has occurred on property adjacent to the west and southeast boundaries of the base. Prior to construction of the base in 1941, the property was used as farmland. Shaw operates two satellite facilities: Poinsett Electronic Combat Range (7.5 miles south of the base) and Wateree Recreation Area (approximately 30 miles north of the base). The Range encompasses 12,520.87 acres, while Wateree encompasses approximately 26 acres.

Beginning as a basic flying school in 1941, Shaw AFB was under the Tactical Air Command. Numerous changes have occurred at the base with the shifting of the aircraft, but the mission has always been to provide tactical fighter forces. To support the base's mission of providing for tactical fighter forces, quantities of petroleum, oils, lubricants (POL); solvents; and coatings were used and applied with resulting waste generation. The host organization for the base is the 20th Fighter Wing. In addition, several tenant units are located at the base. The 20th Fighter Wing has four F-16 Fighter Squadrons. The base and its fighter wing are now under the Air Combat Command.

2.2 PDBS Site Description

The site to be sampled using PDBS is Operable Unit 4 (OU-4). This site is also known as solid waste management unit 59 (SWMU 59) or Former Fire Training Area No. 1 (FT-01). The location of OU-4 is shown on Figure 2.1 and a site layout is shown on Figure 2.2. FT-01 was operated from 1941 to 1969 for the purpose of conducting weekly

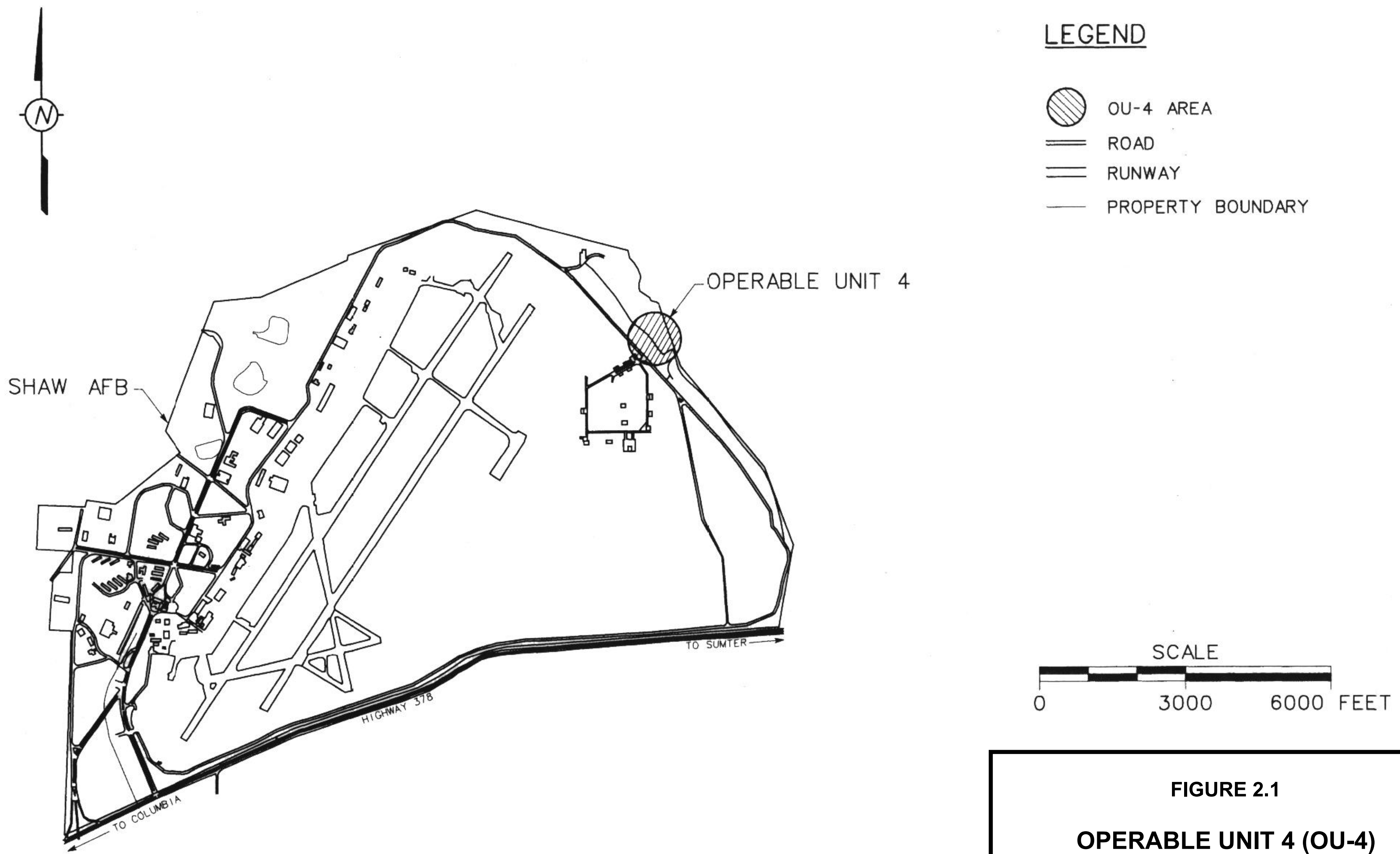

FIGURE 2.1

OPERABLE UNIT 4 (OU-4) LOCATION MAP

Passive Diffusion Bag Sampler Demonstration
Shaw AFB, South Carolina

PARSONS
Denver, Colorado

Source: IT Corporation.

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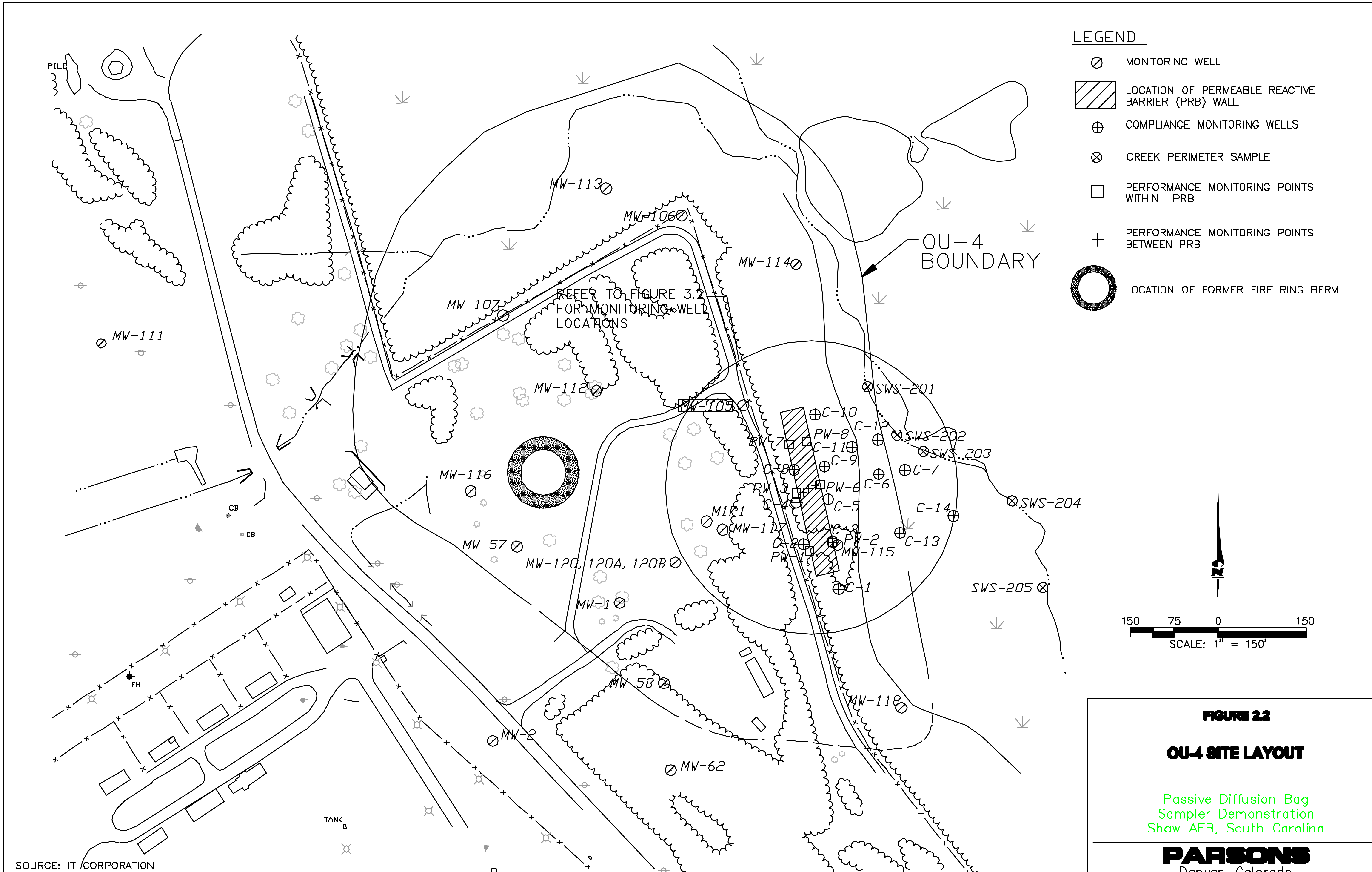

FIGURE 2.2

OU-4 SITE LAYOUT

Passive Diffusion Bag Sampler Demonstration
Shaw AFB, South Carolina

PARSONS
Denver, Colorado

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fire training exercises (Law Environmental, Inc. 1991). A variety of combustible wastes including jet fuel, hydraulic fluid, waste oils, spent solvents, contaminated fuels, and napalm were used in training exercises to demonstrate the effective use of various extinguishing agents. Waste materials were hauled to the site in drums and poured into the bermed pit and ignited. The pit was unlined and liquid combustible wastes are believed to have penetrated the sandy soils underlying the pit. Based on historic aerial photographs, it appears the location of the fire ring was moved periodically during operation of the facility (RUST, 1995). It was further reported that some of the empty drums used to store the combustible wastes were buried at the Area of Concern (AOC) 32 Former Waste Pit near OU-4. Beginning in the mid-1960's until the site was closed in 1969, only jet petroleum grade 4 fuel was used for ignition. The extinguishing agents used during these exercises included water, carbon dioxide, protein foam, and aqueous film-forming foam.

2.3 Site Specific Geology and Hydrogeology

2.3.1 Geology

The geologic units underlying the OU-4 area include a series of unconsolidated sand, silt, clay, and gravel layers extending beneath the ground surface to a depth of approximately 600 to 700 feet. These sediments comprise the South Carolina portion of the coastal plain, and rest unconformably upon igneous and metamorphic rocks similar to those found in the Piedmont physiographic province farther to the northwest. The formations that immediately underlie OU-4 are:

- Duplin Formation terrace deposits (Pliocene/Pleistocene)
- Black Creek Formation (late Cretaceous)
- Middendorf Formation (late Cretaceous)

The Black Creek Formation underlies the entire base and is a major source of drinking water in the Sumter area. The Black Mingo Group overlies the Black Creek Formation in the western portion of the base, but has been thinned by erosion in the runway areas and is absent beneath OU-4, where the Black Creek Formation is unconformably overlain by the Duplin Formation.

2.3.2 Hydrogeology

Shallow Aquifer. The shallow aquifer in the vicinity of OU-4 consists of the mostly sandy sediments of the Duplin terrace deposits. This aquifer is underlain by the semi-permeable clayey aquitard at a depth of approximately 80 to 90 feet. The shallow aquifer is stratigraphically divided into two zones. The upper zone extends to approximately 35 feet below ground surface (bgs) and is characterized by mostly medium to very coarse sands with granular and gravelly layers. The lower zone extends from approximately 35 feet bgs to the aquitard at approximately 90 feet bgs. The lower zone consists of a gradual fining of sediments with increasing depth.

The water table is located from 3 to 22 feet bgs at OU-4. The average horizontal groundwater flow rate for shallow groundwater at OU-4 is 1.78 feet per day (ft/day) (IT, 2000). The average transmissivity of the upper portion of the shallow aquifer was determined to be 3,400 square feet per day (ft^2/day). The average hydraulic conductivity for the shallow aquifer is 42 ft/day.

Black Creek Aquifer. The aquitard between the Duplin Aquifer and the Black Creek Aquifer is semi-permeable and probably allows for the slow transmission of water through discontinuities characteristic of its depositional environment. Based on water level measurements, the vertical head drop between the two aquifers is downward and averages 24 feet. Based on minimal differences between water levels in the Black Creek Aquifer wells, the potentiometric surface is essentially flat in this area.

2.4 Chemicals of Concern

Historically, contaminants that have exceeded regulatory limits at Shaw AFB have consisted primarily of chlorinated solvents, their associated breakdown products, and fuel hydrocarbons. Contaminants detected in groundwater at concentrations exceeding regulatory limits during the most recent LTM events are summarized in Table 2.1. The primary chemicals of potential concern (COPCs) in groundwater at OU-4 include acetone, chloroethane, tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichlorethane, 1,1 dichloroethane, 1,1 dichloroethene, vinyl chloride, fuel compounds, semivolatile organic compounds (SVOCs) and metals. Thirty-six wells at OU-4 are sampled quarterly for VOCs using US Environmental Protection Agency (USEPA) Method SW8260B.

3.0 SCOPE OF PDBS DEMONSTRATION

An estimated total of 72 passive diffusion samplers will be installed in 25 monitoring wells at Shaw AFB as part of this project. The monitoring wells that will be sampled during this PDBS demonstration are summarized in Table 3.1, and their locations are shown on Figure 3.1.

3.1 Diffusion Sampling

3.1.1 Field Activities

Monitoring wells selected for VOC sampling using the PDBS technique (Table 3.1) were chosen from the list of monitoring wells targeted for sampling by USACE during the LTM sampling event scheduled to begin in October 2001. Monitoring wells were selected based primarily on VOC concentrations detected during the November 2000 sampling event. Selected wells include 25 wells with historical concentrations of chlorinated solvent and daughter products (Figure 3.1).

PDBSs deployed during this investigation will be installed and retrieved in accordance with the diffusion sampler installation and recovery standard operating procedures (SOPs) presented in Appendix B of the AFILEV PDBS Project Work Plan (Parsons, 2001). PDBSs will be installed throughout the screened interval of each well (i.e., 1 PDBS per 3 feet of saturated screen) to obtain a vertical profile of contaminant

TABLE 2.1
SUMMARY OF MOST RECENT VOC DETECTIONS IN GROUNDWATER
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
SHAW AFB, SOUTH CAROLINA

Contaminant	Well Number	Concentration (μg/L)[a/]	Sample Date
benzene	C1	1.4	Nov-00
benzene	C2A	110	Nov-00
benzene	C2B	58	Nov-00
benzene	C3A	190	Nov-00
benzene	C5A	47	Nov-00
benzene	C8B	4.1	Nov-00
benzene	C9B	14	Nov-00
benzene	C11	15	Nov-00
benzene	C13	86	Nov-00
benzene	P-1A	36	Nov-00
toluene	C2A	1400	Nov-00
toluene	C2B	480	Nov-00
toluene	C3A	710	Nov-00
toluene	C5A	530	Nov-00
toluene	C8B	7.6	Nov-00
toluene	C9B	140	Nov-00
toluene	C11	24	Nov-00
toluene	C13	23	Nov-00
toluene	P-1A	590	Nov-00
toluene	P-2A	710	Nov-00
ethylbenzene	C2A	140	Nov-00
ethylbenzene	C2B	57	Nov-00
ethylbenzene	C3A	58	Nov-00
ethylbenzene	C5A	100	Nov-00
ethylbenzene	C8B	12	Nov-00
ethylbenzene	C9B	64	Nov-00
ethylbenzene	C11	41	Nov-00
ethylbenzene	C13	18	Nov-00
ethylbenzene	P-1A	150	Nov-00
ethylbenzene	P-2A	120	Nov-00
xylenes	C2A	680	Nov-00
xylenes	C2B	339	Nov-00
xylenes	C3A	217	Nov-00
xylenes	C5A	450	Nov-00
xylenes	C8B	23.9	Nov-00
xylenes	C9B	284	Nov-00
xylenes	C11	160	Nov-00
xylenes	C13	32	Nov-00
xylenes	P-1A	680	Nov-00
xylenes	P-2A	670	Nov-00
trichloroethene	C1	1.6	Nov-00
trichloroethene	C2A	2	Nov-00
trichloroethene	C2B	12	Nov-00
trichloroethene	C4A	13	Nov-00
trichloroethene	C4B	0.75	Nov-00

TABLE 2.1 (Continued)
SUMMARY OF MOST RECENT VOC DETECTIONS IN GROUNDWATER
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
SHAW AFB, SOUTH CAROLINA

trichloroethene	MW-105	5.4	Nov-00
trichloroethene	MW115A	4.7	Nov-00
trichloroethene	MW-120	22	Nov-00
trichloroethene	MW-120A	0.91	Nov-00
tetrachloroethene	C1	0.78	Nov-00
tetrachloroethene	C2A	0.89	Nov-00
tetrachloroethene	C2B	2.4	Nov-00
tetrachloroethene	C4A	3.4	Nov-00
tetrachloroethene	C5C	1.2	Nov-00
vinyl chloride	C3A	360	Nov-00
vinyl chloride	C4A	98	Nov-00
vinyl chloride	C4B	91	Nov-00
vinyl chloride	C5A	290	Nov-00
vinyl chloride	C5B	130	Nov-00
vinyl chloride	C5C	2	Nov-00
vinyl chloride	P1-A	110	Nov-00
vinyl chloride	P2-A	150	Nov-00
vinyl chloride	MW-105	0.53	Nov-00
vinyl chloride	MW-115	100	Nov-00
vinyl chloride	MW-117	99	Nov-00
vinyl chloride	MW-120	36	Nov-00
cis-1,2-dichloroethene	C1	13	Nov-00
cis-1,2-dichloroethene	C2A	2100	Nov-00
cis-1,2-dichloroethene	C2B	830	Nov-00
cis-1,2-dichloroethene	C3A	640	Nov-00
cis-1,2-dichloroethene	C4A	1800	Nov-00
cis-1,2-dichloroethene	C5C	17	Nov-00
cis-1,2-dichloroethene	C8B	25	Nov-00
cis-1,2-dichloroethene	C11	210	Nov-00
cis-1,2-dichloroethene	C13	1.2	Nov-00
cis-1,2-dichloroethene	MW-105	320	Nov-00
cis-1,2-dichloroethene	MW-115	45	Nov-00
cis-1,2-dichloroethene	MW-117	400	Nov-00
1,1-dichloroethane	P-1A	870	Nov-00
1,1-dichloroethane	P-2A	290	Nov-00
1,1-dichloroethane	MW-105	1.6	Nov-00
1,1-dichloroethane	MW-115	350	Nov-00
1,1-dichloroethane	MW-117	690	Nov-00
1,1-dichloroethane	MW-120	4600	Nov-00
1,1,1-trichloroethane	MW-117	760	Nov-00
1,1,1-trichloroethane	MW-120	1100	Nov-00
1,1,1-trichloroethane	MW-120A	4.1	Nov-00
1,1,1-trichloroethane	MW-120-B	1.6	Nov-00

[a/] µg/L = micrograms per liter

TABLE 3.1
SAMPLING LOCATION SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
SHAW AFB, SOUTH CAROLINA

Well Number	Total Depth (ft)[a/]	Well Diameter (in)[a/]	Screened Interval (ft bgs)[b/]	Dominant Lithology of Screened Interval	Approximate Water Level Range (ft below TOC)	Aquifer Unit	Dedicated Pump yes/no (Y/N)	Estimated Number of PDBSs	Main COCs Concentrations from Most Recent Sampling (µg/L)[b/]	Comments/Sampling Rationale
C1	25.0	2	5-25	Sand	4.27 - 5.46	Shallow	N	6	Nov. 2000 - benzene: 1.4, TCE: 1.6, PCE: 0.78, cis-1,2-DCE: 13	Historical detections of chlorinated compounds and benzene.
C2A	12.0	2	2-12	Sand	5.21 - 7.35	Shallow	N	2	Nov. 2000 - benzene: 110, toluene: 1400, ethylbenzene: 140, xylenes: 680, TCE: 2, PCE: 0.89, cis-1,2-DCE: 2100	Historical detections of chlorinated compounds and BTEX. **Check for LNAPL prior to deploying PDBS.**
C2B	24.0	2	14-24	Sand	5.16 - 7.29	Shallow	N	3	Nov. 2000 - benzene: 58, toluene: 480, ethylbenzene: 57, xylenes: 339, TCE: 12, PCE: 2.4, cis-1,2-DCE: 830	Historical detections of chlorinated compounds and BTEX.
C3A	12.0	2	2-12	Sand	4.53 - 5.57	Shallow	N	3	Nov. 2000 - benzene: 190, toluene: 710, ethylbenzene: 58, xylenes: 217, cis-1,2-DCE: 640, vinyl chloride: 360.	Historical detections of chlorinated compounds and BTEX.
C4A	12.0	2	2-12	Sand	6.28 - 7.46	Shallow	N	2	Nov. 2000 - benzene: 43, toluene: 710, ethylbenzene: 110, xylenes: 530, TCE: 13, PCE: 3.4, cis-1,2-DCE: 1800, vinyl chloride: 98.	Historical detections of chlorinated compounds and BTEX. **Check for LNAPL prior to deploying PDBS.**
C4B	24.0	2	14-24	Sand	6.12 - 7.29	Shallow	N	3	Nov. 2000 - benzene: 14, toluene: 98, ethylbenzene: 25, xylenes: 79, TCE: 0.75, cis-1,2 DCE: 210, vinyl chloride: 91.	Historical detections of chlorinated compounds and BTEX.
C5A	12.0	2	2-12	Sand	4.00 - 4.98	Shallow	N	3	Nov. 2000 - benzene: 47, toluene: 530, ethylbenzene: 100, xylenes: 450, cis-1,2-DCE: 260, vinyl chloride: 290.	Historical detections of chlorinated compounds and BTEX.
C5B	24.0	2	14-24	Sand	3.97 - 4.93	Shallow	N	3	Nov. 2000 - benzene: 20, toluene: 250, ethylbenzene: 58, xylenes: 295, cis-1,2-DCE: 270, vinyl chloride: 130.	Historical detections of chlorinated compounds and BTEX.
C5C	35.0	2	25-34	Sand	3.96 - 4.92	Shallow	N	3	Nov. 2000 - benzene: 1.8, toluene: 1.4, ethylbenzene: 0.65, xylenes: 2.5, TCE: 0.54, PCE: 1.2, cis-1,2-DCE: 17, vinyl chloride: 2.	Historical detections of chlorinated compounds and BTEX.

TABLE 3.1 (Continued)
SAMPLING LOCATION SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
SHAW AFB, SOUTH CAROLINA

Well Number	Total Depth (ft)[a/]	Well Diameter (in)[a/]	Screened Interval (ft bgs)[b/]	Dominant Lithology of Screened Interval	Approximate Water Level Range (ft below TOC)	Aquifer Unit	Dedicated Pump yes/no (Y/N)	Estimated Number of PDBSs	Main COCs Concentrations from Most Recent Sampling (µg/L)[b/]	Comments/Sampling Rationale
C8B	24.0	2	14-24	Sand	6.31 - 7.43	Shallow	N	3	Nov. 2000 - benzene: 4.1, toluene: 7.6, ethylbenzene: 12, xylenes: 23.9, cis-1,2-DCE: 25, vinyl chloride: 4.2.	Historical detections of chlorinated compounds and BTEX.
C9B	24.0	2	14-24	Sand	4.39 - 5.33	Shallow	N	3	Nov. 2000 - benzene: 14, toluene: 140, ethylbenzene: 64, xylenes: 284, cis-1,2-DCE: 140, vinyl chloride: 25.	Historical detections of chlorinated compounds and BTEX.
C9C	35.0	2	25-35	Sand	4.54 - 5.43	Shallow	N	3	Nov. 2000 - toluene: 4.7, ethylbenzene: 2, xylenes: 10, cis-1,2-DCE: 2.3.	Historical detections of chlorinated compounds and BTEX.
C10	25.0	2	5-25	Sand	5.72 - 6.64	Shallow	N	6	Nov. 2000 - benzene: 6.1, toluene: 4.9, ethylbenzene: 19, xylenes: 28.5, cis-1,2-DCE: 1.3, vinyl chloride: 0.85.	Historical detections of chlorinated compounds and BTEX.
C11	19.7	2	14.7 - 19.7	Sand	3.58 - 3.78	Shallow	N	2	Nov. 2000 - benzene: 15, toluene: 24, ethylbenzene: 41, xylenes: 160, cis-1,2-DCE: 210, vinyl chloride: 8.3.	Historical detections of chlorinated compounds and BTEX.
C13	6.0	2	0.5-5.5	Sand	2.82 - 3.30	Shallow	N	1	Nov. 2000 - benzene: 86, toluene: 23, ethylbenzene: 18, xylenes: 32, cis-1,2-DCE: 1.2.	Historical detections of chlorinated compounds and BTEX.
C14	6.0	2	0.5-5.5	Sand	3.70 - 4.09	Shallow	N	1	Nov. 2000 - benzene: 12, toluene: 0.78, ethylbenzene: 0.37, xylenes: 1.52, cis-1,2-DCE: 190, vinyl chloride: 23.	Historical detections of chlorinated compounds and BTEX.
P-1A	12.0	2	2-12	Sand	5.36 - 6.48	Shallow	N	2	Nov. 2000 - benzene: 36, toluene: 590, ethylbenzene: 150, xylenes: 680, 1,1-DCA: 870, 1,1-DCE: 230, vinyl chloride: 110.	Historical detections of chlorinated compounds and BTEX.
P-2A	12.0	2	2-12	Sand	4.50 - 6.34	Shallow	N	2	Nov. 2000 - benzene: 52, toluene: 710, ethylbenzene: 120, xylenes: 670, 1,1-DCA: 290, 1,1-DCE: 300, vinyl chloride: 150.	Historical detections of chlorinated compounds and BTEX.

TABLE 3.1 (Continued)
SAMPLING LOCATION SUMMARY
PASSIVE DIFFUSION BAG SAMPLER DEMONSTRATION
SHAW AFB, SOUTH CAROLINA

Well Number	Total Depth (ft)[a/]	Well Diameter (in)[a/]	Screened Interval (ft bgs)[b/]	Dominant Lithology of Screened Interval	Approximate Water Level Range (ft below TOC)	Aquifer Unit	Dedicated Pump yes/no (Y/N)	Estimated Number of PDBSs	Main COCs Concentrations from Most Recent Sampling (µg/L)[b/]	Comments/Sampling Rationale
MW-105	19.7	2	14.7 - 19.7	Sand	11.29 - 14.19	Shallow	N	2	Nov. 2000 - 1,1-DCA: 1.6, 1,1-DCE: 0.53, cis-1,2-DCE: 320, PCE: 0.51, TCE: 5.4, vinyl chloride: 0.53.	Historical detections of chlorinated compounds.
MW-115	25.0	2	3 - 18	Sand	2.00 - 4.94	Shallow	N	4	Nov. 2000 - 1,1-DCA: 350, cis-1,2-DCE: 45, vinyl chloride: 100.	Historical detections of chlorinated compounds.
MW-115A	69.08	2	59.1 - 68.6	Sand	3.50 - 9.05	Shallow	N	3	Nov. 2000 - TCE: 4.7.	Historical detections of TCE.
MW-117	21.41	2	6.5-20.9	Sand	9.80 - 15.70	Shallow	N	2 or 3	Nov. 2000 - 1,1,1-TCA: 760, 1,1-DCA: 690, cis1,2-DCE: 400, vinyl chloride: 99	Historical detections of chlorinated compounds.
MW-120	27.0	2	15-25	Sand	14.82 - 16.60	Shallow	N	3	Nov. 2000 - 1,1,1-TCA: 1100, 1,1-DCA: 4600, 1,1-DCE: 210, cis1,2-DCE: 900, PCE: 4.3, TCE: 22, vinyl chloride: 36.	Historical detections of chlorinated compounds. **Check for LNAPL prior to deploying PDBS.**
MW-120A	47.0	2	35-45	Sand	14.83 - 16.50	Shallow	N	3	Nov. 2000 - 1,1,1-TCA: 4.1, 1,1-DCE: 1.1, PCE: 11, TCE: 0.91.	Historical detections of chlorinated compounds.
MW120B	72.0	2	60-70	Sand	18.18 - 21.06	Black Creek	N	3	Nov. 2000 - 1,1,1-TCA: 1.6, 1,1-DCE: 5.3, PCE: 8.6, TCE: 3.6.	Historical detections of chlorinated compounds.

Notes:
TCE = Trichloroethene; cis-1,2-DCE = cis-1,2-Dichloroethene; PCE = Tetrachloroethene;
Xylenes = total xylenes.
[a/] ft = feet; in = inches.
[b/] BGS = below ground surface; µg/L = micrograms per liter; TOC = top of casing.
[c/] NA = not available.
[d/] ND = not detected. If no COCs were detected during the most recent sampling, data is provided for the most recent event with detections.

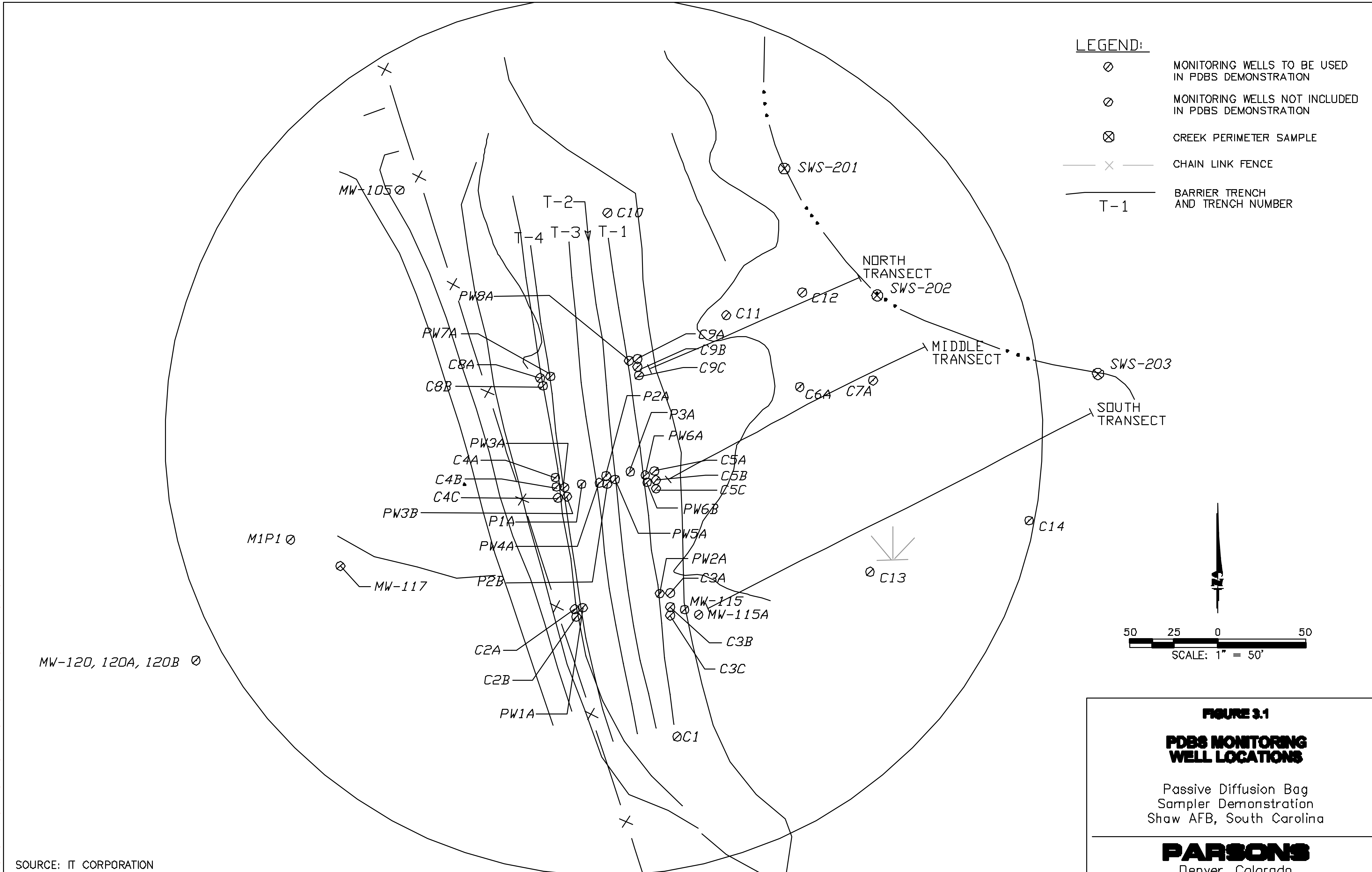

FIGURE 3.1

PDBS MONITORING WELL LOCATIONS

Passive Diffusion Bag Sampler Demonstration
Shaw AFB, South Carolina

PARSONS
Denver, Colorado

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concentrations. The PDBS samples will be collected prior to conventional sampling of the wells. Analysis of the vertical profiling samples is discussed in Section 3.1.2.

Sample aliquots from PDBSs installed in all the wells targeted for sampling will be shipped to Katahdin Laboratory in West Brook, Maine for VOC analysis using USEPA Method 8260B. This is the same laboratory that will be used by USACE for analysis of the samples collected via conventional techniques during the LTM event starting in October 2001. Field quality control samples will be collected at the following frequencies:

- 10 percent field duplicates;
- 5 percent matrix spikes and matrix spike duplicates;
- 1 pre-installation equipment rinseate blank;
- 1 pre-installation source water blank; and
- 1 trip blank per cooler of samples.

The Quality Assurance Program Plan (QAPP) for the LTM program at Shaw AFB will be adopted as the site-specific addendum to the PDBS QAPP as appropriate.

3.1.2 Contaminant Profiling

Per the AFILEV project work plan (Parsons, 2001), contaminant profiling within the screened intervals of the monitoring wells is intended to be conducted using field-screening methods, with only the sample exhibiting the greatest VOC concentrations, based on the field analysis method, being submitted for laboratory analysis.

Field-screening will be performed using direct sampling ion trap mass spectrometry (DSITMS) technology via USEPA SW846 Method 8265. DSITMS is an innovative technology for determining the presence or absence and measuring the concentration of VOC's and SVOC's in air, water and soil. DSITMS introduces sample materials directly into an ion trap mass spectrometer by means of a very simple interface such as a capillary restriction or a polymer membrane. There is very little, if any, sample preparation and no chromatographic separation of the sample constituents meaning that the response to the analytes or contaminants in a sample is instantaneous.

All samples will be analyzed in the field using a field ready DSITMS by Tri-Corder Environmental, Inc. (McLean, VA). For each well, the sample resulting in the highest concentration of total VOCs, based on field screening, will be shipped to Katahdin Analytical Services for VOC analysis using EPA Method 8260B. If the field screening result for all samples within one monitoring well screened interval are below the method detection limit, the sample collected from the PDBS positioned closest to the saturated screen midpoint will be sent to the laboratory for analysis.

3.1.3 Analytical Results Comparison/Evaluation

Analytical results for groundwater samples collected using the PDBSs and using conventional techniques will be compared, and the results will be evaluated. Typically, if maximum concentrations from the PDBS are higher than concentrations in samples collected using the conventional method, it is probable that the concentrations from the PDBS are more representative of ambient groundwater chemistry conditions than are the conventional-sampling data (Vroblesky, 2001). If, however, the conventional method produces VOC results that are higher by a predetermined amount than the concentrations reported for the PDBS, then the PDBS may not adequately represent local ambient groundwater conditions. In this case, the difference may be due to a variety of factors, including hydraulic and chemical heterogeneity within the saturated screened interval of the well, vertical flow of groundwater within the well, and/or the relative permeability of the well screen with respect to the surrounding aquifer matrix (Vroblesky, 2001).

Considering the above guidance, if the maximum analytical result obtained using the PDBS is greater than or equal to the conventional sampling result, it will indicate that the PDBS method is appropriate for use in that particular well and no further comparison of results will be performed. However, if the maximum PDBS result is less than the conventional sampling result, further comparison of the two sets of results will be undertaken. In this instance, analytical results for samples collected using the diffusion samplers will be compared to results from the conventional sampling using relative-percent-difference (RPD), as defined by the following equation:

$$RPD = 100*[abs(D-C)]/[(D+C)/2]$$

Where:

abs = absolute value

D = diffusion sampler result

C = conventional sample result.

For this investigation, an RPD of less than 15 (McClellan AFB, 2000) will be considered to demonstrate good correlation between sample results. Calculated RPDs in excess of 15 will be reviewed individually in an attempt to determine the reason for the variance.

3.2 Monitoring Network Optimization Evaluation

A portion of the groundwater monitoring network at this installation will be evaluated using both qualitative assessments and a geographical information system (GIS)-based algorithm that performs statistically based temporal and spatial analyses of monitoring-well information. Locations and completion intervals of individual monitoring wells and sampling points will be examined, and the informational contribution of each well or sampling point to the network will be weighed against the cost of monitoring at that point. Monitoring protocols and analytical methods also will be evaluated. Where warranted, recommendations will be developed for optimization of the portion of the monitoring network that is evaluated. Methods to be used in the evaluation will include, but are not limited to, qualitative hydrogeologic and hydrochemical analyses, application of statistical optimization techniques, and application of decision-logic structures.

A maximum of 30 monitoring wells at this installation will be evaluated as part of this task. Parsons will coordinate with Shaw AFB to determine which wells to include in the evaluation. The results of the evaluation will be included in the Site-Specific Diffusion Sampler Demonstration Report for Shaw AFB.

4.0 PROJECT ORGANIZATION

Addresses and telephone numbers of the Shaw PDBS management and support team are as follows:

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Ms. Andrea Colby	Katahdin Analytical Services	340 County Road No. 5 West Brook, ME 04092	(207) 874-2400 web site: www.katahdinlab.com email: acolby@katahdinlab.com	(207) 775-4029

5.0 SCHEDULE

Work performed as part of this demonstration at Shaw AFB will be completed according to the schedule summarized below.

- Submittal of the Draft Shaw AFB PDBS Work Plan to commenting parties: August 8, 2001
- Receipt of Draft Shaw AFB PDBS Work Plan Comments: August 29, 2001
- Submittal of the Final Shaw AFB PDBS Work Plan: September 21, 2001
- Install PDBS samplers in monitoring wells at Shaw AFB: September 24-25, 2001
- Remove PDBS samplers from monitoring wells at Shaw AFB: October 8-9, 2001
- Preparation of the Draft Shaw AFB PDBS Report: October 15 - December 21, 2001

6.0 REPORTING

The site-specific results report will provide a map and accompanying table identifying the location and depth for each PDBS sample collected. Analytical results obtained as part of this study will be compared to conventional-sampling analytical results collected by IT in a scientifically defensible manner using statistical analyses. The results of the statistical comparisons will be presented in a clear and logical manner in the results report. Statistical methods will include calculation of RPDs between PDBS and conventional sampling results, and possibly parametric or non-parametric analysis of variance (ANOVA) tests. The draft version of this report will be distributed according to the schedule presented in Section 5.

7.0 REFERENCES

McClellan AFB. 2000. Final Passive Diffusion Membrane Samplers Technology Application Analysis Report. National Environmental Technology Test Sites (NETTS). August.

Parsons. 2001. *Draft Work Plan for the Air Force Environmental Directorate Passive Diffusion Sampler Demonstration*. April.

Rust Environment and Infrastructure, 1995, *Final Remedial Investigation Report, Operable Unit #4, Former Fire Training Area No. 1, IRP Site No. FT-1, Shaw AFB, South Carolina*, Volume 1, prepared for US Department of Air Force, February 20, 1995.

Law Environmental, Inc., 1991, *Draft Remedial Investigation and Feasibility Study Report for Site 1 – Former Fire Training Area No. 1, Shaw AFB, Sumter, South Carolina,* prepared for the US Army Corps of Engineers – Omaha Division, December 1991.

Vroblesky, D. A. 2001. *User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells*. US Geological Survey Water-Resources Investigations Report 01-4060. Columbia, South Carolina.

APPENDIX A

HEALTH AND SAFETY PLAN ADDENDUM